BULLETIN No. 156.

ROSE MILDEW

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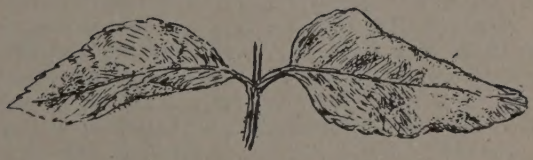

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AGRICULTURAL EXPERIMENT STATION,
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THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 156. SEPTEMBER 1911.

ROSE MILDEW.

By J. B. S. Norton and Thos. H. White.

Powdery mildew is one of the most common and injurious diseases of roses, wherever they are grown. In regions where the climate is most suitable for outdoor rose culture, mildew is also prevalent; but here it is rarely troublesome except in the greenhouse, where it often causes serious injury. A few varieties, the Crimson Rambler and some related forms especially, are badly injured outdoors, but much less so when grown away from walls so that they have free air exposure.

The mildew is usually first noticed as grayish or whitish spots on the young leaves or shoots, these being more or less distorted by the disease. Later as the spots enlarge they have a white, powdery appearance, or on the stems, or thorns more than elsewhere, may have a quite felt-like coating. After a few weeks as the affected parts mature, the mildew appearance is lost and the injured portions show a dark color.

The young leaves, stems and buds are dwarfed, curled or variously deformed by the disease. The foliage is reduced by the deformation and killing of parts of the leaf surface, and by the dropping of the injured leaves, and growth and flower production is seriously interfered with. The young buds themselves are often attacked by the mildew, the flower clusters of the Ramblers sometimes being completely covered by it and entirely worthless.

CAUSE OF MILDEW.

If one of the very young mildew spots which can just be distinguished is examined with a microscope which magnifies 10 or 20 diameters, one can easily see that the spot consists of a mold-like

growth such as is shown in Figure 1. This fungus * is composed of slender, white threads with numerous branches, running out from the center of the spot and forming a net-work over the surface of the rose leaf. At various points these threads produce a different kind of branches, which are erect and bear on their ends chains of minute egg-shaped bodies (spores) which are easily detached and in older spots lie in masses on the surface and give it a powdery appearance.

Figure 2 shows a cluster of spore-bearing branches greatly enlarged. Figure 3 shows one very highly magnified, indicating the internal appearance of the spores,—a mature one detached at *a*. Figure 5 shows thickly felted mildew on a Crimson Rambler thorn (x50) with less dense growth of spores on the younger portion at the left.

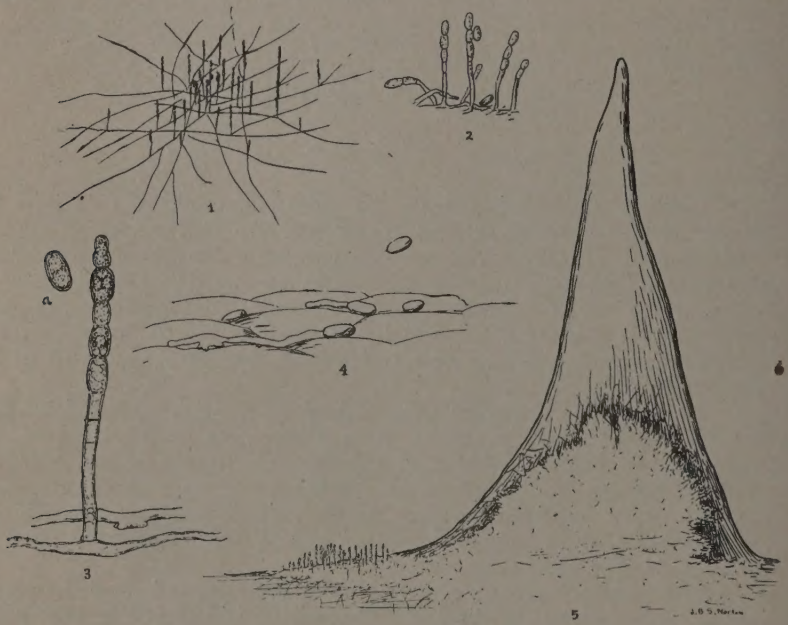

Fig. 1-5.—The mildew fungus.

(*) There are two powdery mildew fungi occurring on roses, *Sphaerotheca pannosa* (Wallr.) Lev. and *S. humuli* (D C.) Burr. In Salmon's monograph (Mem. Torr. Bot. Club 9. 1900) he states that practically all the American rose mildews which he had seen were *S. humuli*. Almost all American authors, however, both before and since that time, consider our rose mildew to be *S. pannosa*. The two are hardly to be separated in the conidial stage, and perithecia are rarely found on rose mildews and then only out doors. From all reports it seems certain that *S. pannosa* is common here, but published data, especially from Europe, with regard to *S. pannosa* should be considered with caution when applied to American greenhouse mildews on roses. For a recent discussion of this question see Stewart, N. Y. Exp't Sta. Bull. 328: 390. 1910.

The spores drop from their stalks when mature and are blown about freely by the slightest air currents. By touching a mildewed shoot in the light with a dark background, one can easily see a shower of the fine, dust-like spores. They germinate readily, and a careful examination of a young leaf that has been exposed to them, with a microscope of high magnifying power, will show them in various stages of growth as indicated in Figure 4 (diagramatic). The little thread which comes from the germinating spore grows quickly, branches and in a few days is producing a new crop of spores.

At various points, later indicated by brown or black specks on the mildewed spots, the threads are attached to the rose surface and even send minute branches into the outer cells of leaf or stem and draw their nutriment from them. In this way most of the damage is done, though the presence of the felted mass of mildew may also interfere with the action of light upon the leaves and the passage of gases into and out of them. The cells which are being drawn upon by the mildew fungus appear to be first stimulated to a slightly more vigorous growth, as indicated by the attacked spots being raised on the mildewed side while the opposite side of the leaf shows a depression, but they soon die from the injury.

While it is easy to see that certain climatic conditions favor the occurrence of mildew, just as certain conditions are necessary for the proper development of roses, careful work by many students of fungi has shown that unless the fungus is present there will be no mildew, no matter what the climatic conditions, just as there could be no roses, however favorable the air and soil, unless there are cuttings or seeds to start from.

A single spore will produce thousands of new ones in a week, more or less, and each of these, so easily carried through the air, is capable of making a new mildew spot if it gets a chance to grow on young rose tissue. Thus the mildew can spread with great rapidity.

These spores probably do not live a long time and are easily killed, but other means are provided for carrying the fungus over long periods unfavorable to the growth of mildew. Rarely, and chiefly out doors, another form of spore, able to live over winter is produced in little spore-cases which appear as minute, dark specks embedded in the felt-like mildew on stems, thorns, etc. It is probable also that the mildew threads themselves live over winter out doors in the winter buds of roses. Laubert * mentions certain new shoots of rose being covered with mildew from the first in spring, while others were entirely free from it. The same condition is frequent with apple mildew in Maryland.

There is a great difference in susceptibility of varieties. In addition to the Ramblers already mentioned, Ellwanger † says that the varieties of Giant of Battles type are very subject to mildew;

(*) Laubert and Schwartz, Rosenkrankheiten und Rosenfeinde. 1910.

(†) Ellwanger, The rose. 1898.

and according to Foster-Melliar* varieties with soft, spongy leaves are first attacked, while hard, shiny, well glazed leaves such as the teas, do not suffer so much except in greenhouses. Powdery mildew of peach, almond, apricot and cherry laurel is considered to be caused by the same species of fungus as the rose mildew.

EXPERIMENTS.

The experiments conducted may be considered under three heads:
(1) The relation of drafts to mildew.
(2) Controlling by burning sulfur.
(3) Controlling by vaporizing sulfur.

THE RELATION OF DRAFTS TO MILDEW.

Many florists believe that rose mildew is caused by drafts. There are good reasons for this theory, for it has been noticed many times that roses get badly mildewed when exposed to a draft. Mildew will be noticed first in that part of a house subject to a light draft, it may be only from an open door or a broken pane of glass. Growers recognize this, hence very minute directions for the control of the ventilation are given by writers on rose growing.

When the new greenhouses were erected at this Experiment Station in the summer of 1908, one house, 20x50, was prepared with a partition running across the center. This divided the house into two sections. Top ventilation was arranged as usual on both sections. The north section in addition to this was provided with narrow ventilators close to the ground, so that cold air would enter beneath the benches. The idea was that air could be admitted this way and the temperature modified without any drafts on the plants. Of course it was recognized that the heated air could not pass off as readily as it would at the apex of the roof but for the purpose of the experiment would give comparative results.

The roses were planted and cared for in the usual way. The ventilation, however, was given through the summer months by opening the top ventilators in both sections. After the weather began to get cool in September the top ventilators in the north section were kept entirely closed and only the low-down, side ventilators were used. These worked very satisfactorily except that it was found necessary to hang a cloth curtain in front of the opening, so that the incoming air was admitted about six inches from the floor. The other or south section was ventilated always from the top. No other means were taken for the prevention of mildew. Early in October the fungus was noticed in the section ventilated at the top. This spread very rapidly until there was considerable infection. Later, small patches were noticed in the section that was ventilated only from below. As this appeared in direct line of the door connecting the two sections it was concluded that the infection came through the door in the

(*) Foster-Melliar, The book of the rose. 1902.

draft from the other section. After infection the fungus continued to spread and in order to save the crop of roses, sulfur was painted on the pipes. The following season the experiment was tried again and careful attention was paid to the closing of the partition door. Mildew again appeared in the top ventilated section early in the winter. It was late in February, however, before any showed in the north section. This time it appeared in the northeast corner and was noticed after several days of a prevailing wind in that direction. Sulfur was again used to control the infection.

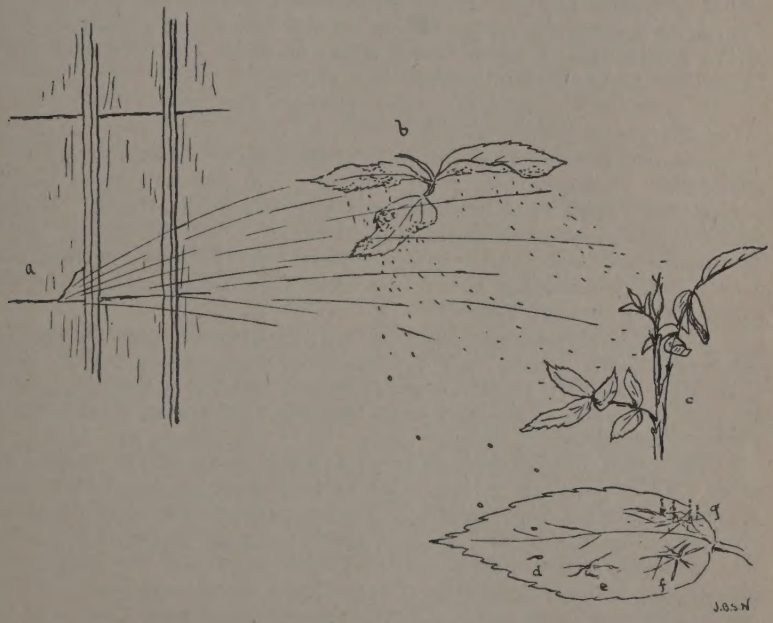

Fig. 6.—Diagram showing how mildew spreads.

In the meantime in order to test the atmospheric conditions and their relation to mildew, some small plants were inoculated with the spores and placed under different conditions as follows: One was placed under a bell-jar in the rose-house where the air conditions would be very warm and moist. Another was left free on the bench beside the bell-jar and another carried into a room where the temperature was low and the air dry. Other plants, uninoculated, were used as checks, one under a bell-jar and one outside. Those on the bench were exposed to a slight draft from a broken glass nearby. On the sixth day mildew appeared on all the inoculated plants. On the plant in the humid conditions of the bell-jar it only developed on the very softest leaves. This was practically the same with the one left

on the bench. The plant in the cool, dry room was infected on all the younger leaves. None of the uninoculated plants showed any signs of mildew. Another potted plant badly affected with mildew was placed beneath a bell-jar in which the temperature, as shown by a thermometer, ran up as high as 130 degrees F. and came out in a few days with the mildew apparently all killed.

Figure 6 is a diagram showing how mildew may be disseminated by drafts. The air currents from the broken glass at *a* are shown carrying the spores which fall from the mildewed leaf at *b* to the young rose shoot at *c*. The leaf below shows various stages of mildew (*d, e, f, g*), from the spores falling on the leaf and germinating at *d* to the production of spore chains again at *g*, all greatly enlarged in proportion to the leaf on which they appear.

CONTROLLING BY BURNING SULFUR.

The two devices used for this purpose were obtained from men advertising in the florists trade papers. The first one tried was a copper shell, cylindrical in shape, and perforated all around. It was supplied with two small doors and a handle or bale to carry it with. There was an upper and a lower section. In the upper section was a cast iron pan holding about two tablespoonfuls of sulfur. In the lower was an alcohol lamp.

The directions were to light the alcohol lamp and melt the sulfur, after which the melted sulfur was set on fire with a match. The apparatus was then to be carried through the house and be swung from side to side. This was to be kept up until the odor of the sulfurous gases could be detected.

The other device seemed to be a home made affair, having the same idea of burning sulfur. But instead of the alcohol lamp, this apparatus used sulfur candles. These candles consisted of about two ounces of sulfur tied up in a small piece of cheese cloth. This was evidently dipped into and coated with paraffin. The sulfur was burned by setting fire to the cheese cloth, which was kept burning by the coating of wax. These devices were tried several times and the vapor made quite strong but the mildew was not killed. One time the gases were so strong that various tender weeds on the benches were severely injured. The roses, however, and the mildew were not affected. Since that time, while using an apparatus for boiling sulfur, the sulfur caught fire and before it was noticed had filled the house with the blue vapor. The ventilators were opened at once, but serious damage had resulted, several plants loosing their foliage entirely. This was a much larger dose than the manufacturers of these devices recommended, yet the mildew did not seem to be killed.

CONTROLLING BY VAPORIZING SULFUR *.

The apparatus used for this work is called the Campbell vaporizer. In this the sulfur boils over an alcohol lamp but does not burn. This is very effective and safe if the directions are closely followed. The principal feature of this device is the pot in which the boiling takes place. There being only a small opening in the top of this vessel it is almost impossible for the sulfur to get on fire. It must be watched, however, for it will sometimes, if quite full, boil over. The vapors given off in this apparatus are entirely different to those in which the sulfur is burned. Soon after the lamp is lighted a rather heavy, yellow vapor rises from the mouth of the pot. This seems to be composed of very fine particles of sulfur. After a few moments this vapor begins to settle down all over everything in the house. Thus all the foliage is covered with a fine layer of sulfur. The effect on the mildew does not seem to be immediate, but after a few days the grayish looking fungus disappears and nothing but the black scars are left.

The common method of painting the heating pipes with a mixture of sulfur and a small amount of lime has a similar effect on the mildew, but a much less dense vapor is seen †.

OBSERVATIONS AND CONCLUSIONS.

1. Mildew, if allowed to get a hold, soon spreads over the entire house, unless conditions are against it. One of the conditions favorable to the spread of mildew is dry, cool air, such as would come into a greenhouse from ventilation, broken glass or open doors. Under such conditions the plants are to a certain extent wilted. The same air conditions favor the spread of the spores. A close and moist condition of the atmosphere is not favorable to the spread of mildew but may make the plants very soft and succulent and the youngest and most succulent portions of the plant are most readily affected by the disease.

2. The low-down side method of ventilation, while it retards the appearance of mildew, would not be practicable in a range of houses.

3. The mildew should be controlled when the attack is comparatively slight. If mildew shows, no time should be lost in vaporizing sulfur to kill off the spores. As the fungus developes from the spore and matures a new crop of spores in six or eight days it only

(*) Maynard of Massachusetts reported in 1889 (Hatch Exp. Sta. Bulletin 4) the successful use of volatilized sulfur for the control of rose mildew, black spot and even red spider. He used a handstove on which the sulfur was kept heated to near the boiling point in a thin iron kettle for 3 or 4 hours, 2 to 3 times a week, or enough to give a visible vapor in the house, taking every precaution to prevent burning the sulfur. A somewhat similar method is used by some Maryland rose growers. There is much danger of the sulfur taking fire in the open kettle and ruining the whole house.

(†) According to Kreamer (Proc. Am. Phil. Soc. 45: 157. 1906; Science 23: 941. 1906), the gas slowly given off from the pipes is sulfuric acid.

takes a short to infect the entire house. During the winter when firing is going on and the pipes are hot, painting them with sulfur will usually keep down mildew. At other times a sulfur vaporizing appliance will be found very useful. The appliances for burning sulfur are useless to control the trouble and the chance for injury is very great.

Outside rose mildew can be controlled by spraying with concentrated lime-sulfur solution, 1 to 50 of water, or any good fungicide, applied frequently.

5. A very heavy vapor from boiled sulphur does not injure the foliage but did injure outer petals of half blown roses.

6. The over dose of burning sulphur killed the leaves badly but did not seem to injure the petals of half open buds.

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ROSE MILDEW.

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